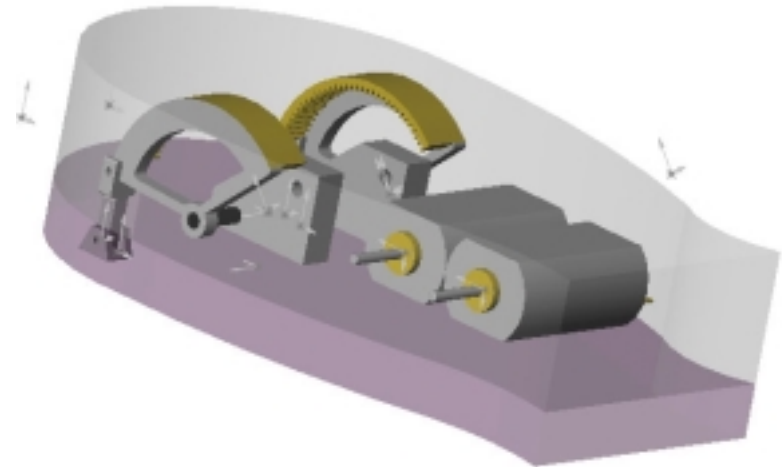
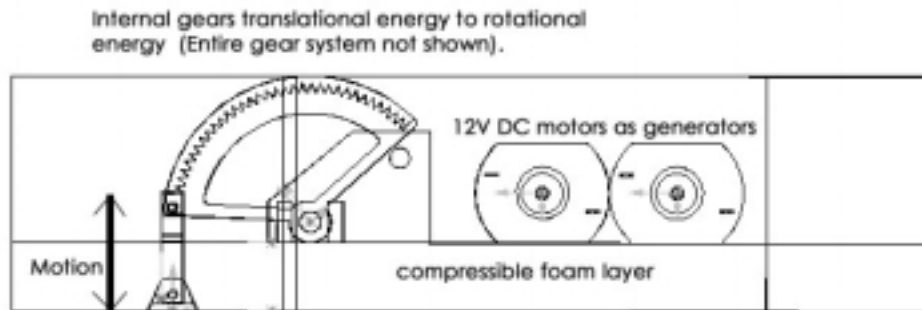


Improved Mechanics



- Drive pair of efficient motor/generators from heel strike
 - Mechanics encapsulated into sole
 - Built into standard running shoe sole
 - 1-cm flex layer (purple) added
- Expect Watt-class output
 - Especially if flywheels on motors

Jeff Hayashida - ME undergraduate thesis project

The Electric Bolo



- Saul Griffith (MIT Media Lab)
- Claims approx. 5 Watts...

Applications onboard shoe

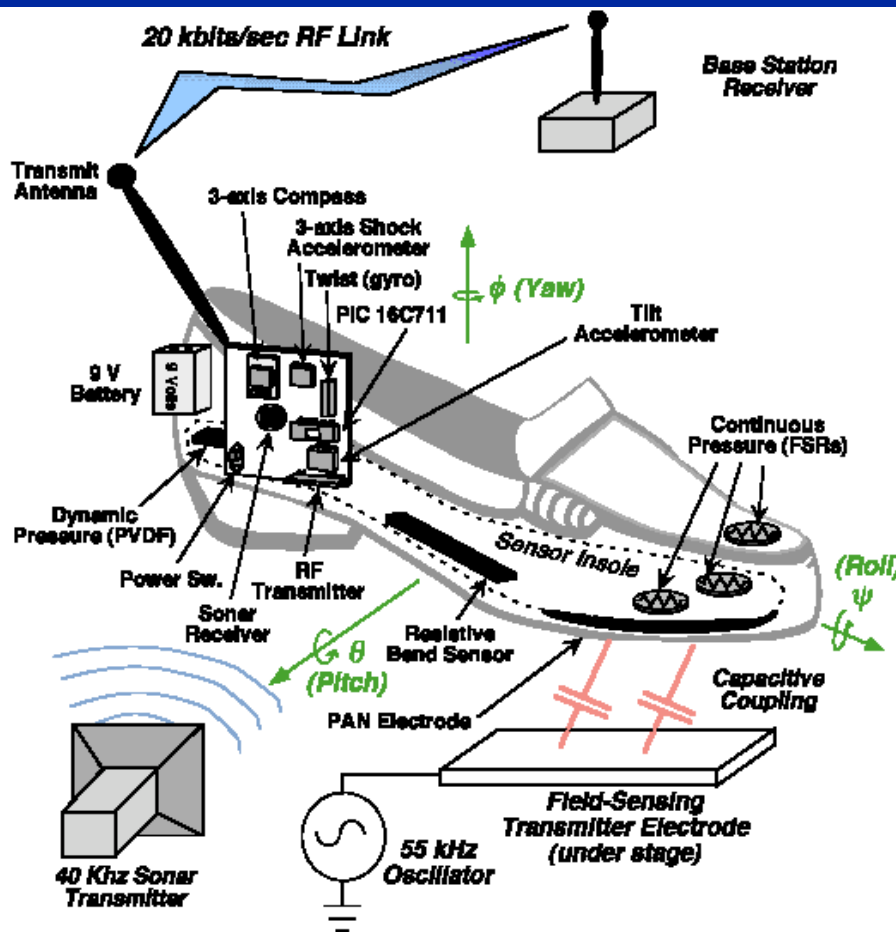
- Battery charge
 - Long popular, heating up (Bayshore and Electric Shoe Company plus Texon)
- Podiatry
 - Pressure/gait warning for diabetics with vascular problems and neuropathy
- Active Insoles
- Athletics/Recreation
 - Pedometry, GPS, data logging, sensing...
 - MP3 Players (wireless headphones)?
- BodyNet and TouchTags
- Wireless “cruncher” hub for wearable system

Feasibility from 10 - 250 mW

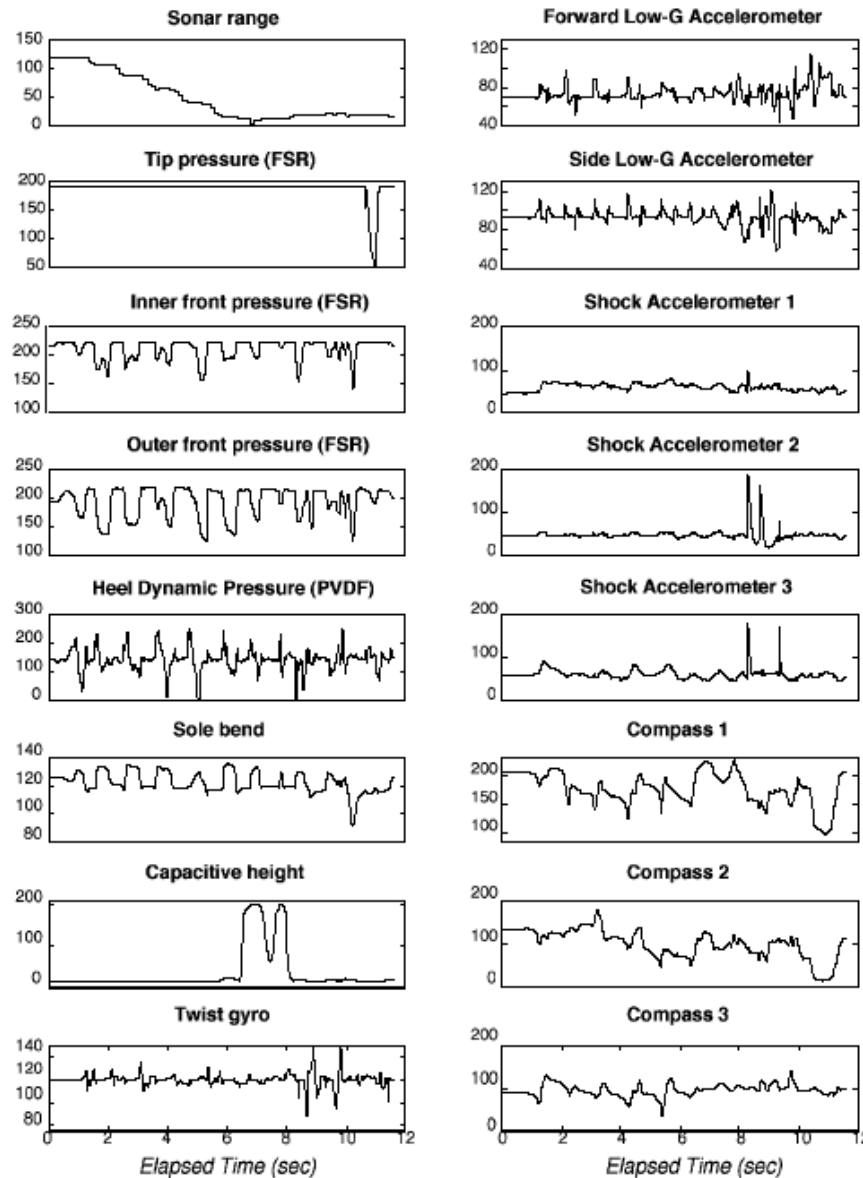
Expressive Footwear

17 Data Channels

- 2-axis tilt sensor
- 3-axis compass
- 1-axis rate gyro
- 3-axis shock sensor
- Height sensor (EFS)
- Sonar receiver
- 1 PVDF strip (sole)
- 3 FSR pressure tabs (sole)
- Bend sensor (sole)
- 3 Volt Battery Reference
- Battery low detect
- 20 kb/sec wireless
- 413 & 433 MHZ
- PIC 16C711
- 50 Hz updates from each foot.
- ~ 50 mA draw
 - Half day or more of life

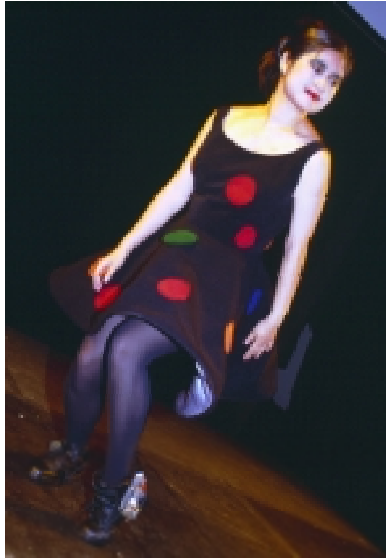


Multisensor Data



- Podiatric Medical Therapy
- Sports Training/Therapy
- Dance Training
- *Expression!!*

Applications...



*MIT Wearables 97
Dancer*



*NICOGRAPH 98
Gymnast*



*Tokyo Toy Fair 99
Juggler*



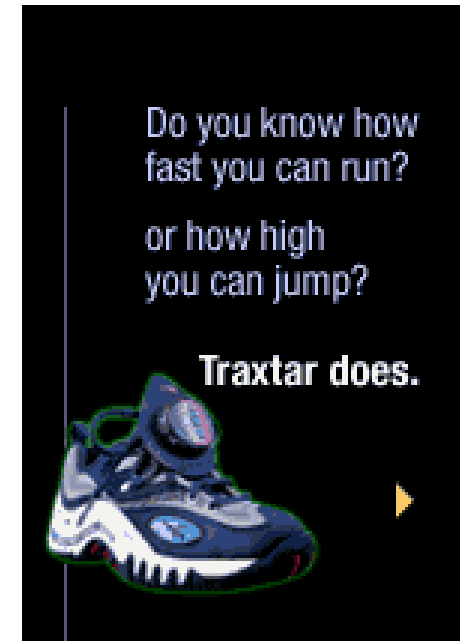
*ADF 99
Byron Suber*



*SENS@BLES 99
Mark Haim*

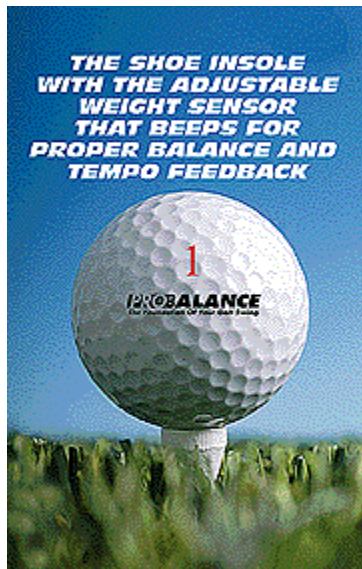
<http://www.media.mit.edu/resenv/danceshoe.html>

Pedometry and Data Logging



- Simple accelerometer and lightweight processor on shoe
 - Infer and log basic kinematics and dynamics
 - Becomes a .com business!
 - GPS someday (Mike Hawley's ski's)
- Reebok Traxtar, PedInc, etc.

Pressure and Balance



www.pro-balance.com

Recreation

www.clevemed.com

Medical

Active Insoles



Meet The Raven

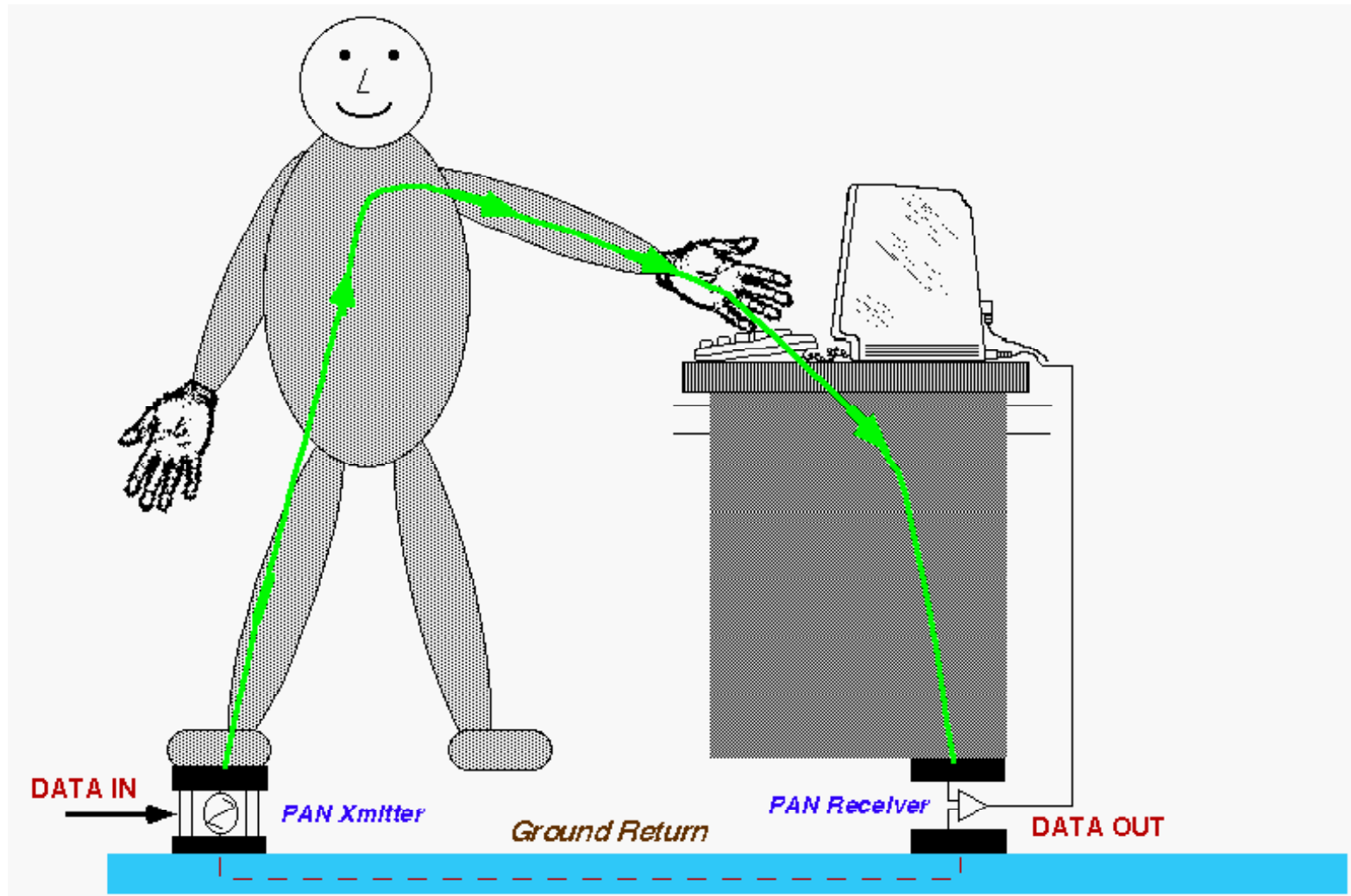
Imagine shoes that think... The Raven, featuring VectraSense ThinkShoe™ technology, senses your activity and dynamically adjusts the shoe so you perform better. Using a small embedded computer that senses your motions, it adjusts the shoe in less than 2 seconds. Providing 300% more cushioning than conventional footwear, the computer gives you optimal support and cushioning when you need it.

Air Bladder

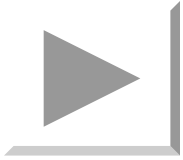
VECTRASENSE TECHNOLOGIES

- Senses running or walking
- Adjusts air bladder response accordingly
- www.VectraSense.com
 - Ron Demon, MIT/LCS (ML alum) spinoff

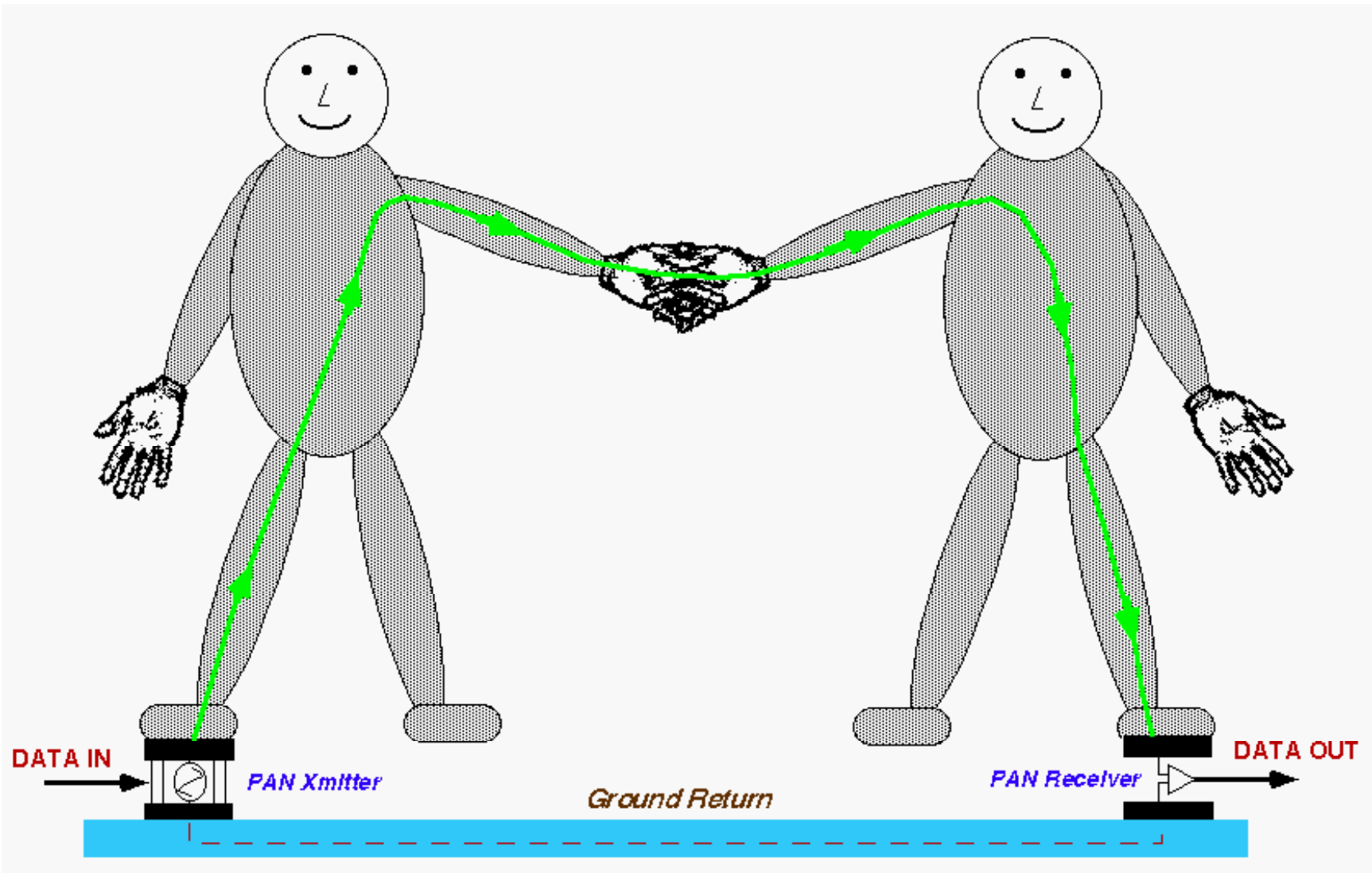
PAN Touch Communication



Note: PAN transceiver can be embedded in PC keyboard



The PAN Handshake



Off the Shoe - Smart Wardrobe

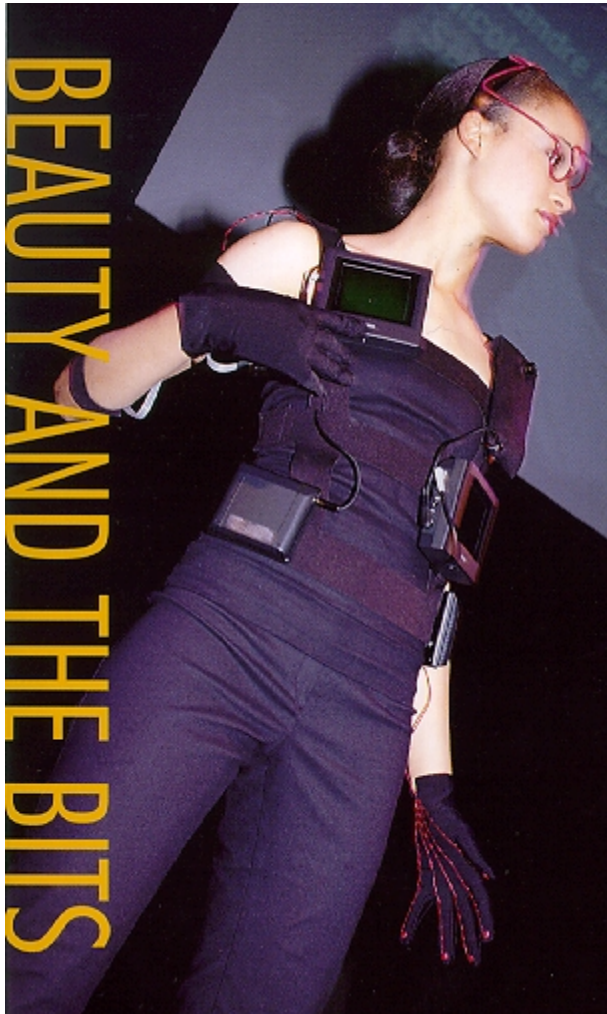


- Computers, displays, sensors, wireless, in clothing
- Many, many applications...
 - Sensory augmentation
 - Memory & “mental” augmentation
 - Nonlocality; consolidation, communication
 - Security, military
 - Medical monitoring
 - Data logging, hands-free
 - Delivery, transaction , tour guide, repair...

The MIT Media Lab Cyborgs, 1995



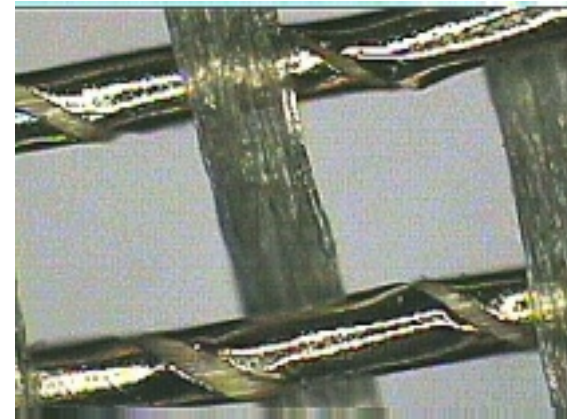
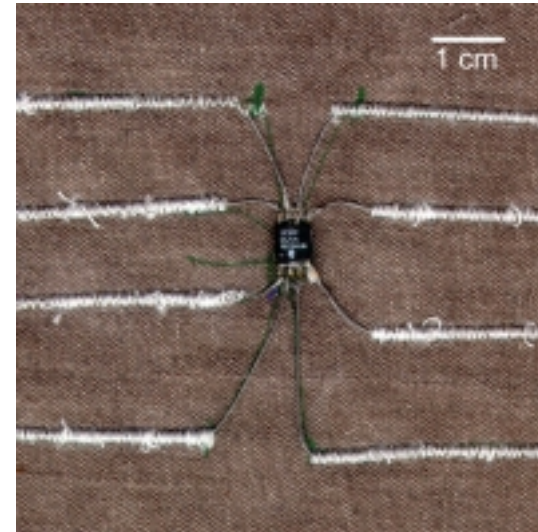
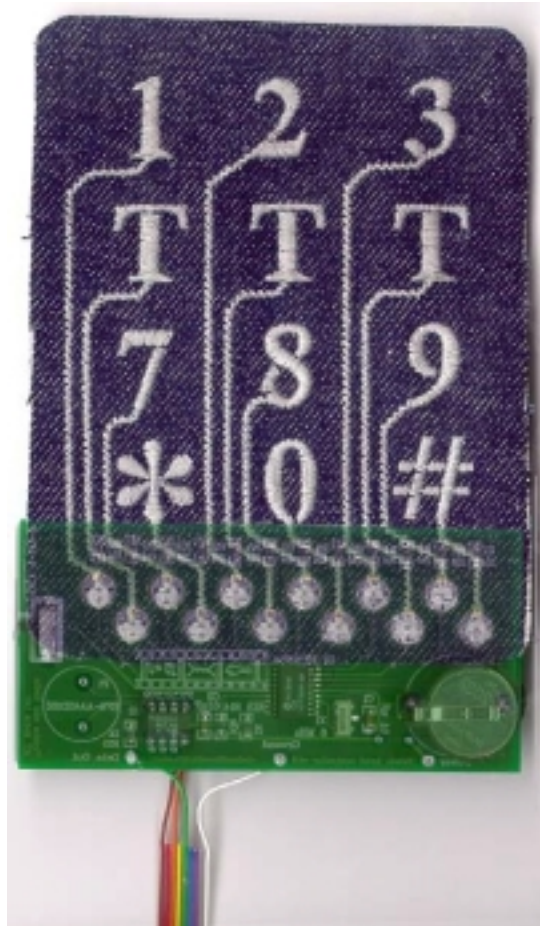
Fashion Shows



- *MIT - October 1997*
- *CalArts - February 1998*
- *Tokyo - November 1998*



Wires in Clothing



- Sticking or wires in fabric pockets?
 - Spotweld to chips on fabric
- Snap connectors, conductive velcro

Rehmi Post, Maggie Orth

Human-Powered Electronics - The Endpoint?



The Matrix, film by the Wachowski Brothers, United Artists 1999

- **We are dim bulbs...**
 - A resting human dissipates about 100 Watts

They will use us in more creative ways...

References

<http://www.media.mit.edu/resenv/papers.html>

- Parasitic Power Harvesting in Shoes John Kymisis, Clyde Kendall, Joseph Paradiso, and Neil Gershenfeld. Proc. of the Second IEEE International
- Conference on Wearable Computing, (ISWC), IEEE Computer Society Press, pp. 132-139, October 1998.
- Clyde Jake Kendall -- Parasitic Power Collection in Shoe-Mounted Devices (pdf) June 1998.
- Nathan S. Shenck -- A Demonstration of Useful Electric Energy Generation from Piezoceramics in a Shoe (pdf) May 1999.